

Title

Arrangement for illuminating objects with light of different wavelengths

Field of the invention

The invention relates to an arrangement for illuminating objects with light of different wavelengths in microscopes, automatic microscopes, and equipment for fluorescent microscopy applications, e.g. in readout equipment for titer plates and biochip readers.

Prior art

In wide-field fluorescent microscopy, halogen or arc lamps are generally used as sources of white light in combination with spectral filters in order to bring electromagnetic radiation of suitable wavelengths for observation or measurement onto an object to be examined or onto a specimen to be examined.

However, such sources of white light have a brief service life, so that the light source must frequently be changed. These light sources are also characterized by the development of a good deal of heat, which can have unfavorable effects on the observations and measurements. Furthermore, the spectral portions in the light sources that are not used must to a great extent be suppressed in some manner. An additional disadvantage of these light sources is that it is not possible to turn them on and off rapidly, because the light sources tend to have an afterglow.

Light sources with a light output of greater than 100 mW, which is adequate for wide-field fluorescent microscopy, are known and available. These are

primarily color LEDs with a spectral half-width value of approximately 20 to 50 nm. However, there are also white light LEDs that have spectral maximums in the blue and green range of the spectrum. The outputs of color LEDs are comparable to the light output that a halogen or arc lamp has after spectral filtering to approximately 20 to 60 nm bandwidth of the excitation light.

For visual illumination purposes in microscopy, it is the state-of-the-art to overlay three or more LEDs on different wavelengths (RGB light sources) in order to obtain white light, e.g. for projection purposes.

DE 100 17 823 A1 describes a microscopic illumination apparatus with a light source embodied as a light diode arrangement. This diode arrangement can comprise white light diodes or even infrared light diodes and can be embodied such that different types of illumination, such as incident illumination, transmitted light illumination, or combined illumination of the objects to be examined can be realized. It is also possible to attain "oblique" illumination of the object.

The disadvantage of this illumination device is that there is no provision for turning on and placing different LEDs in the illumination ray path of the microscope.

#### Description of the invention

The object of the invention is to create a light source arrangement, in particular for fluorescent microscopes, that permits rapid and precise positioning of LED radiation sources that emit light of the same and/or different wavelengths one after the other in the illumination ray path of a microscope.

This object is inventively attained in an arrangement embodied in accordance with the preamble with the characterizing means of the first claim. Additional designs and details of the invention are disclosed in the subordinate claims. The receiving apparatus is advantageously embodied as a rotary table that is rotatable about the axis and on which the mounts are provided.

In accordance with a first embodiment of the inventive arrangement, it is advantageous when the mounts are embodied and arranged on the receiving apparatus and are attached to the receiving apparatus such that the main emission direction of the at least one LED arranged thereon runs parallel to the axis of rotation.

In accordance with another embodiment of the invention, it can also be advantageous that the mounts of the receiving apparatus are embodied and arranged on the receiving apparatus such that the emission direction of the at least one LED arranged thereon runs radial to the axis of rotation.

In order to bundle or align the radiation generated by the LEDs and/or homogenize it, collimator optics and/or a radiation homogenizer known in the field per se are provided in the equipment housing in the light direction downstream of the light emission window of the housing.

In order to cover gaps in the spectrum of the light that are not covered by single-color LEDs, it is furthermore advantageous when at least one of the LEDs is a white light-emitting LED (white light LED).

So that the LED used can be operated with higher current and thus a higher light yield can be attained, a Peltier cooling element for cooling the LED is provided arranged between the mount of the receiving apparatus and the LED arranged thereon.

For certain applications it can also be advantageous that a halogen light source or another light source, e.g. a diode laser, is arranged on at least one mount of the receiving apparatus.

The housing of the arrangement is advantageously detachably affixed to the equipment housing. It is advantageous when the housing is arranged adjustably on the equipment housing, e.g. using a rapid change ring in the form of a dovetail.

It is furthermore advantageous when at least one LED is arranged exchangeably in the mount, e.g. in a suitable plug-in socket. In addition, at least one LED can advantageously be securely joined to the associated Peltier cooling element.

and can be exchangeably arranged in the mount together therewith. During an exchange, the LED, together with the Peltier cooling element, is then exchanged as a single unit. LED and associated Peltier cooling element can also be detachably joined to one another so that the LED can be exchanged without the Peltier cooling element.

#### Brief description of the drawings

The invention is explained in greater detail in the following using exemplary embodiments. The drawings are as follows:

- Fig. 1 illustrates an arrangement with a receiving apparatus embodied as a rotary table;
- Fig. 2 is a top view of the rotary table with the LEDs arranged thereon;
- Fig. 3 illustrates an arrangement with a receiving apparatus in which the mounts are arranged radial to the axis of rotation;
- Fig. 4 is a top view of the rotatable receiving apparatus;
- Fig. 5 is an arrangement in which collimator optics and a light homogenizer are provided; and,
- Fig. 6 illustrates how the arrangement is attached to the equipment housing.

#### Detailed description of the drawings

Elements and components that have the same design and functional purposes in the figures have the same reference numbers in the description of the exemplary embodiments.

The arrangement for illuminating objects with light of different wavelengths in microscopes, which is illustrated in a simplified fashion in Fig. 1, includes a housing 1 in which is provided a light emission aperture 2 through which the light from LEDs 3 employed as the light source can be introduced into the illumination ray path, e.g. of a fluorescent microscope or readout equipment for titer plates or biochip readers. Arranged in the housing 1 is a receiving apparatus 6 that is arranged on a shaft 4 and that is rotatable about an axis of rotation 5, illustrated in Fig. 1 as a rotary table, that includes mounts 7 to which are attached Peltier cooling elements 8 and the LEDs 3. It is advantageous when the LEDs 3 and the associated

Peltier cooling elements 8 are combined in a single unit in order if necessary to be able to exchange them together in a simple manner. The Peltier cooling element 8 is joined to the associated LED 3 so that the LEDs 3 can be operated with a higher current and thus attain a higher light yield. Four LEDs 3; 3.1 are arranged on the receiving apparatus 6 in Fig. 1. In principle, more or fewer LEDs 3; 3.1 can be present there. The LEDs 3; 3.1 and the associated Peltier cooling elements 8 are advantageously mounted to the receiving apparatus 6 by snap or magnetic mounts (not shown) for simple and rapid exchangeability.

For driving the shaft 4, a drive device 9, e.g. a controllable motor, is provided with which the LED 3 with the desired effective wavelength that is required or suitable for illuminating the objects to be examined (not shown) is positioned in a position upstream of the light emission aperture 2 so that the radiation emitted by the LED 3 can be coupled into the illumination ray path of the equipment. The main direction of emission of the LED 3 is parallel to the axis of rotation 5.

For appropriately controlling the drive device 9, a control unit 10 is provided that can be controlled using suitable software. Alternatively, the LEDs 3; 3.1 can also be positioned manually or by manually controlling the drive device 9.

In the embodiment in accordance with Fig. 1, collimator optics 11 for light bundling and where needed a light filter are provided in the direction of light downstream of the light emission aperture 2. In addition, the emission surface of the LEDs 3; 3.1 can be embodied such that a light-collecting effect is attained. Thus the emission surface of the LED body is embodied in the shape of the lens, as shown in Fig. 1 for the LED 3.1.

Advantageously, in the area of the housing 1 in which the light emission aperture 2 is located, a receiving flange 12 is provided on the housing 1 of the arrangement and includes elements that facilitate rapid attachment of the arrangement to the equipment housing 18.

Fig. 2 is a top view of the receiving apparatus 6 embodied as a rotary table on which are arranged four LEDs 3; 3.1.

Fig. 3 and Fig. 4 illustrate different views of an inventive arrangement with a prismatic receiving apparatus 13, arranged on the shaft 4 driven by the drive device 9, on each of the four circumferential surfaces 14 of which are arranged mounts 7, Peltier cooling elements 8, and the LEDs 3 in a manner analogous to that in the arrangement in accordance with Fig. 1 and Fig. 2. The main emission direction of the LEDs 3 in this embodiment is radial to the axis of rotation 5. Instead of four LEDs 3, more or fewer LEDs can also be provided given appropriate design of the prismatic receiving apparatus 13.

Thus, in this arrangement as well, a mount 7, a Peltier cooling element 8, and the corresponding LED 3 are positioned in series on each circumferential surface 14 of the prismatic receiving apparatus 13. The collimator optics 11 that are associated with the light emission aperture 2 are located in the housing 1 of the arrangement. In this case, as well, the drive device 9 is controlled by the control unit 10.

Fig. 5 is an exemplary illustration of the arrangement depicted in Fig. 1 and Fig. 2 in connection with elements that shape and homogenize the light bundle emitted by the LED 3 through the light emission aperture 2. Thus, a radiation homogenizer 16 is downstream in the direction of light of collimator optics 15 that constitute a plurality of components in this embodiment. A glass or plastic rod acting as a light guide, a hollow rod with a mirrored interior surface, or a light guide filled with liquid that has a round or polygonal cross-section can be provided as radiation homogenizer 16, for instance.

The individual LEDs 3 are preferably selected such that their emitted light has a spectrum that is well matched to the absorption spectra of frequently used fluorophors such as FITS, Cy3, Cy5, APC, etc.

In order to cover gaps in the spectrum of the LEDs 3 during observations and measurements, at least one of the LEDs 3 can be replaced with a white light source 17 (Fig. 2). Preferably a white-light LED that radiates a white light

can also be employed. Alternatively order in addition thereto, an LED position can also be fitted on the mount 7 with a halogen light source 17, e.g. a halogen lamp with a reflector.

Fig. 6 illustrates a preferred simple attachment of the housing 1 of the arrangement to the equipment housing 18 of the microscope or readout equipment. A rapid change ring, e.g. in the form of a dovetail, is provided that comprises the receiving flange 12 arranged on the housing 1 and the counter-piece 19 that is arranged on the equipment housing 18 and that cooperates with the flange 12. This connection makes it possible to rapidly change the entire arrangement.

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Legend

1	Housing
2	Light emission aperture
3	LED
3.1	LED with collecting lens
4	Shaft
5	Axis of rotation
6	Receiving apparatus
7	Mount
8	Peltier cooling element
9	Drive device
10	Control unit
11	Collimator optics
12	Receiving flange
13	Receiving apparatus
14	Circumferential surfaces
15	Collimator optics
15.1; 15.2	Component
16	Radiation homogenizer
17	Halogen light source
18	Equipment housing
19	Counter-piece